VOL. 15 OCTOBER, 1942 NO. 4

Journal

OF THE

Kansas Entomological Society

PUBLICATION COMMITTEE
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1889-1929

Entered as second-class matter June 7, 1939 at the Post Office at Manhattan, Kansas, under the Act of August 24, 1912

Kansas Entomological Society

Volume 15 October, 1942 Number 4

EMERGENCE HABITS OF THE CLEAR LAKE GNAT

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In connection with studies on the biology and control of the Clear Lake gnat, **Chaoborus astictopus** D. and S., which breeds in the waters of Clear Lake, Lake County, Calif., special attention was given to the emergence of the insect from the lake. Information was desired on the daily and seasonal rates of emergence, sex ratio, cycles of activity, and the time of day at which emergence was most frequent, all of which have a bearing on control.

Herms (1937) reported that the pest breeds in Clear Lake and surmised that emergence begins early in the afternoon. Local residents and others asserted that swarms of gnats could be seen emerging or "hatching" out of the water near the shore. The sudden dip and rise of swarms over the water at dusk does give the impression that the insects are issuing directly from the lake. Frequent sampling, however, showed that these swarms were composed almost entirely of females. Furthermore, dissection of representative specimens of these females disclosed mature eggs, which were not found in newly emerged specimens.

METHODS

It was thought that, if cages were placed over the water, information on emergence could be obtained. After several trials with different types and sizes of cages, a floating pyramidal cage was developed. The cage is made of 18-mesh screen wire, is open on the bottom, and covers 9 square feet of water surface. The top is fitted with a wide-mouth quart Mason jar containing a cone into which the gnats are driven when the cage is covered with a dark-colored hospital rubber sheeting. The jar can be unscrewed and replaced. The cages are anchored by means of a rope and weight. The pupae come to the surface preparatory to adult emergence, and when the adults come up under the cage they are caught. However, the journey from the bottom mud is not made rapidly, and the effect of currents and the swimming of the pupae does not mean that all the insects coming up into the cage originate in the mud directly beneath it. As a matter of fact, great differences were observed in the catches of the various cages, and it is evident that in many cases the pupae moved hundreds of feet horizontally before the adults emerged.

A few cages were operated at various distances off shore in the latter part of August and in September, 1938. A cage 220 feet off

shore showed little emergence, but cages farther out took various number of gnats. In 1939 a line of five cages (line A) was established at right angles to the shore near the upper end of the lake on the east side near the village of Nice. The first cage was approximately 1,000 feet off shore and the others were a little over ½ mile apart, making the fifth cage about 2½ miles off shore. A line of three cages (line B) parallel to line A was operated 3,000 feet down the lake. The cages in line B were placed in the same relative position as the first three cages nearest shore in line A. The emerged insects were taken out of the cages daily and brought to the laboratory. The cages were established April 26 and were continued in use until October 15. The cages in line A were operated throughout the seasons of 1939 and 1940. The average seasonal emergence from the first three cages in line A was 555 insects to the square foot and those in line B 580.

EMERGENCE IN CAGES IN LINE A, 1939-40

An outstanding finding was that throughout the two seasons in which the cages in line A were in operation emergence occured every day on which observations were made. There were 8 days in 1939 and 6 days in 1940 when storms prevented examination of the cages. A lack of well-defined generations is indicated by daily emergence and suggests that factors are operative which limit a steady development of the organism. From the point of view of control, an attack against the emerging insects would be a never-ending endeavor.

In table 1 is shown the monthly emergence from the various cages in line A. In 1939 the average monthly emergence from all the cages ranged from 48.9 gnats per square foot in May to 134.6 per square foot in July and in 1940 from 42.1 in May to 252.0 in August.

The daily emergence can be characterized as sporadic and irregular. The emergence per square foot has ranged from less than 1 to 75. A graph of the daily numbers taken is jagged and appears to have little significant regularity except as it relates one cage to another. The same characteristic has been found in gnats the larvae of which were taken in mud samples from the bottom and brought to the laboratory for emergence studies. From two lots of mud, each containing an estimated 200 larvae collected on June 1, 1939, 6 adults emerged.

At the end of 53 days many live larvae remained without having transformed. Similarly, on June 8, 19 adults emerged in one jar and 14 in another, and live larvae were recorded in both jars 45 days later. In these and similar tests the larvae were fed, but probably inadequately. On August 18 mud containing an estimated 800 larvae was placed in a 6-gallon jar and plankton was added frequently. A total of 130 adults emerged over a 41-day period, and during this

Table 1.—Emergence of **Chaoborus astictopus** in five cages in line A located from approximately 1,000 feet to about 2½ miles off shore on Clear Lake, Calif., 1939-40.

Date	Number of Gnats per Square Foot					
	Cage 1	Cage 2	Cage 3	Cage 4	Cage 5	Average
1939						
May	94.0	81.8	17.9	29.2	21.5	48.9
June	157.2	225.7	66.6	70.6	51.3	114.3
July	226.7	208.2	65.7	87.6	84.8	134.6
August	112.8	148.0	23.0	81.0	119.8	96.9
September	40.1	98.9	97.3	116.4	109.0	92.3
Total	630.8	762.6	270.5	384.8	386.4	487.0
Percent of total	25.9	31.3	11.1	15.8	15.9	——
1940						
May	39.3	54.4	48.8	26.8	41.1	42.1
June	66.0	113.9	101.7	52.1	91.2	85.0
July	182.9	252.5	116.2	81.3	107.2	148.0
August	382.9	429.8	143.8	41.9	261.8	252.0
September	185.7	114.4	97.3	58.8	177.9	126.8
Total	856.8	965.0	507.8	260.9	679.2	653.9
Percent of total	26.2	29.5	15.5	8.0	20.8	——

time the water temperature ranged from 70° to 80° F. Live larvae were observed in the jar 5 months later.

Of special interest is the fact that cages 1 and 2 in line A, those close to shore, recovered the greatest numbers of gnats during both years. In 1939, 25.9 and 31.3 percent, respectively, of the total were taken in these two cages and in 1940, 26.2 and 29.5 percent. During short periods the emergence was less in these cages than in those farther out. The combined recovery of these two cages was 57.2 percent of the total in 1939 and 55.7 percent in 1940. This is remarkably consistent and is supporting evidence that the cages reflect actual conditions. Cages 3 and 5 showed somewhat similar percentages both years, but cage 4 took only 8.0 percent in 1940 and 15.8 percent in 1939. The monthly figures for the different cages varied somewhat, but in general a uniform consistency is manifest.

The large emergence in cages 1 and 2 is noteworthy when the record of the larval and pupal population in the bottom and in the vicinity of the cages is studied. In 1939 samples of bottom mud, into which the larvae and pupae retreat during the daylight hours, were taken twice a week with a 6-inch Ekman dredge at cages 1, 3, and 5. On a square-foot basis a total of only 150 pupae were taken during the season at cage 1, while 730 and 808 were recovered at

cages 3 and 5, respectively. Similarly, 8,044, 13,700, and 13,508 larvae were taken near these cages. The ratio of larvae to pupae in the three cages was 54.4 to 1, 18.8 to 1, and 16.7 to 1. It will be noted that the greatest emergence apparently occurred in the area of the lowest population and that the least emergence took place where larvae and pupae had been noted as abundant. Frequently at cage 1 no pupae were found, but large emergences nevertheless occurred. The explanation for this phenomenon is that, when the pupae leave the bottom mud during the night, they are transported by currents or exhibit a voluntary migration, seeking quieter or warmer water for emergence. Miller (1941) observed emergence of **Chaoborus punctipennis** at all depths in Costello Lake, Ontario, Canada. He states that "pupae may evidently stray or be carried far from their larval habitat." If currents are moving the pupae, the question arises as to why the larvae are not similarly transported with a resulting concentration close to shore.

That the mature larvae are scarce close to shore is evident from examination of thousands of bottom samples. It seems probable that pupae are less resistant to water currents than are mature larvae, and possibly the pupae keep moving until water or temperature favorable for emergence is found.

SEASONAL EMERGENCE

The emergence from the five cages in line A by half-month totals and the water temperatures at these cages during 1939 and 1940 are shown in fig. 1. In 1939 emergence reached its peak in the last half of July and in 1940 the peak was reached in the first part of August. In both years emergence declined following the peaks until the first part of October, when very few adults issued. The number of pupae taken twice monthly in bottom samples of mud at 15 stations over the lake showed a similar trend through the season; that is, more pupae were taken during the latter part of July and the first part of August than during May, June, and September. The dip in curves during the first part of July, 1939 and the last part of June, 1940 represents the decline of the overwintering generation. In 1939 the overwintering generation continued to emerge from April 24 to at least July 1, a period of 67 days. This was determined by studying bottom samples and noting the appearance of the new crop of larvae.

The finding that the emergence of the overwintering generation is a long-drawn-out process definitely limits a quick, decisive attack against the adults for control purposes. In 1940 the emergence of the overwintering generation could not be followed definitely later than June because of a heavy new crop of larvae. The prolonged

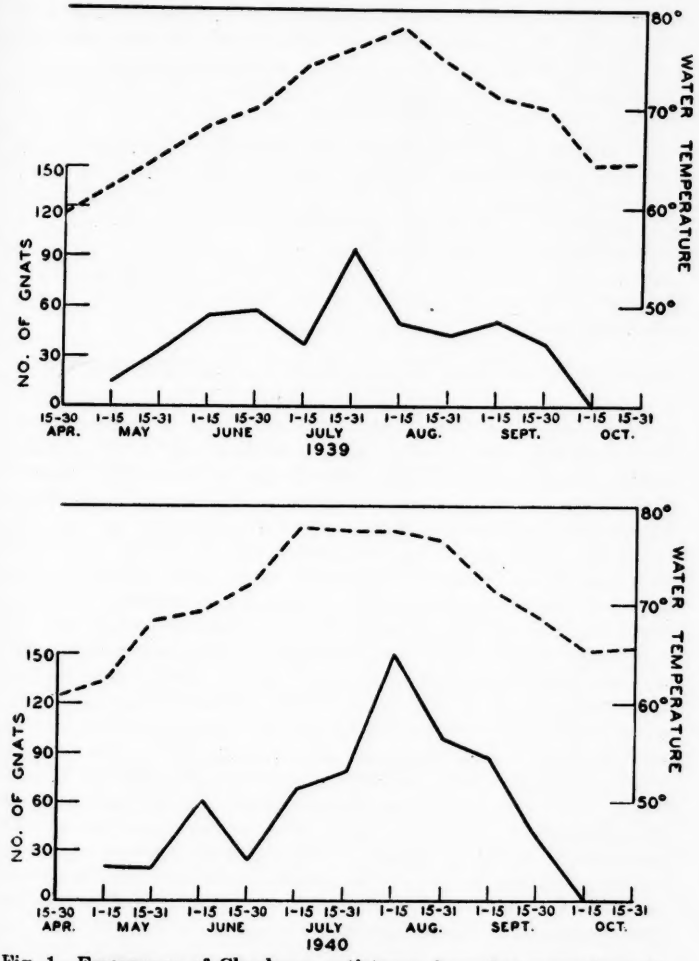

Fig. 1—Emergence of **Chaoborus astictopus** from five cages by half-month-totals, together with water temperatures, 1939-40.

period of emergence of the overwintering larvae can be attributed only to variations in food and temperature, although both factors appeared to be favorable. In the light of this long period and the absence of peak emergencies during the latter part of the season, the

conclusion is reached that the number of generations probably does not exceed 2 or 3, depending on the date of the first oviposition in the spring. There is of course much overlapping of generations. The life cycle can, however, be extremely rapid—from 14 to 20 days when larvae are fed to repletion in the laboratory.

A perplexing problem has been the decrease in emergence during the latter part of August and September, in spite of previous heavy oviposition. Heavy oviposition during the first part of August and also during the latter part of that month has not been followed by a large emergence or a notable increase in the number of the immature stages. This would seem to indicate either that egg laying is not sufficient to populate the lake, which does not appear likely, or that a heavy mortality of the immature stages occurs.

EFFECT OF WATER TEMPERATURE, AIR TEMPERATURE, AND STORMS ON EMERGENCE

A study of the water temperature in relation to emergence reveals that the gnats began issuing from the lake in measureable numbers in the spring of 1939 when the water temperature reached 62.2° F. In May and June the temperature of the water was below 70° until the last few days of June. Nearly one-third of the season's emergence took place during these months. In the middle of Septem- when the water temperature dropped to 70° the emergence had fallen off markedly and dropped to practically nothing when the water temperature reached 64.1°. The same trend of events occurred in September, 1938, when the emergence fell off considerably at 70° and practically ceased at 65°. The developments in 1940 were similar. It is interesting to note that **Chaoborus astictopus** emerged in the spring in large numbers at water temperatures of 62° to 70°, but in the fall pupation and emergence were greatly reduced at 70° and nearly ceased at 65°. It appears that some other factor or factors beside temperature causes the diminution in fall emergence. It is probable that the availability of larval food has a bearing on this phenomenon. In the spring the overwintering generations of larvae are all equal size or in the last instar, owing to growth during the fall and winter, and they are ready for pupation and emergence at comparatively low temperatures.

Eggleton (1932), in discussing **Chaoborus punctipennis** Say in Third Sister Lake, Washtenaw County, Michigan, has observed what appears to be a cessation of pupation and emergence in the fall. He states that "the full-grown larvae appear, even in late autumn, to be in the last larval instar, but are prevented from pupating by some factor or factors—perhaps the falling temperature of the water—present until spring when, perhaps owing to rising temperature, they

pupate and emerge in the first spring swarms." Eggleton attributes the failure of the grown larvae to pupate in autumn to unfavorable temperature, which may be a factor, but a perusal of the data on bottom temperatures of Third Sister Lake (Eggleton, 1931) shows the following for 1928: April 6, 40.6° F.; April 20, 43.2°; May 23 and June 6, 43.7°; October 10 and November 3 and 10, 45.7°. These figures show a gradual increase in temperature during the season with the warmest period in the fall. It appears that the increased temperatures should have accelerated pupation, but from the data available both species, namely, C. **astictopus** and C. **punctipennis**, appear to slow up or cease pupation in the fall, notwithstanding temperatures which appear to be favorable. Degree of availability of larval food and other factors probably contribute to this phenomenon.

In this connection an interesting comparison between the two species can be made. Eggleton states that larvae of **Chaoborus punctipennis** taken from the lake in the winter and warmed gradually to 59° to 68° pupated in 24 to 48 hours. C. **astictopus** taken from Clear Lake in October, November, and December and subjected to temperatures of 70° to 80° and fed plankton did not pupate for long periods. No pupation occurred in less than 20 days, and usually a much longer period was required.

Pupae have been recovered in Clear Lake by seining with large nets as early as April 15 at a water temperature of 58° F. In Blue Lake, a small neighboring body of water, **Chaoborus astictopus** pupae were taken in bottom samples of mud at the rate of 29.2 per square foot on May 6, 1940, when the water temperature was 52°. On May 8, in Clear Lake, pupae were found at the rate of only 6.4 per square foot at a water temperature of 62.3°. Under certain conditions it appears that pupae can form under the remarkably low temperature of 52°. Eggleton (1932) reported larvae of C. **punctipennis** pupating and emerging usually by the first week in April in Third Sister Lake. The bottom water temperature in this lake on April 6, 1928, was 40.6 F°. Muttowski (1918) states that C. **punctipennis** begins to pupate in Lake Mendota about June 10, and large swarms emerge continually from June 15 to August 20. The last adults emerge about September 30. It appears that this species has various habits in different lakes.

Air temperatures do not ordinarily have much direct effect on emergence of **Chaoborus astictopus** except insofar as they influence water temperatures. The insect issues from the lake during the coolest part of the day, and the usual minimum air temperatures of 48° to 58° F. apparently are not deleterious to flight. Lower temperatures, which are infrequent during the summer, occasionally

destroy the emerging gnats.

Storms with attendant heavy wave action no doubt affect emergence, although recovery of gnats in the cages has occurred after all-night blows. Unusually strong waves probably prevent emergence or destroy the issuing insects.

RATE AND TIME OF EMERGENCE AND SEX RATIO

As shown in table 1, the total seasonal emergence from the various cages in 1939 ranged from 270.5 to 762.6 gnats per square foot, with an average of 487.0, and in 1940 it ranged from 260.9 to 965.0 gnats, with an average of 653.9. These numbers are considerably less than might be expected. The larval population as determined by 33 bottom samples taken at 11 stations on April 26 averaged 920 larvae per square foot before appreciable emergence commenced and dropped to 84 on June 24. The difference of 836 should be represented by emergence, but during this time an average of only 163 insects per square foot, or approximately one-fifth of the larvae, were accounted for by recovery in the cages. This discrepancy is explained by certain facts. First, it was clearly established that great emergence occurred close to shore far removed from the observed larval and pupal concentration. The shifting of the pupal population away from this center toward the shore of the lake dispersed the insects over twice as large an area as the original; hence in the calculation of total emergence the entire water area must be considered. Furthermore, intermittent operation of the cages beyond cage 5 and also farther down the lake indicated a larger emergence which would increase the average.

Another explanation of the above discrepancy is that as the pupae near shore they become subject to attack by certain shore-feeding species of fish, with a consequent decimation of numbers. This phenomenon has been demonstrated by the finding of nearly as many pupae as larvae in the stomachs of the Sacramento perch, **Archoplites interruptus** (Girard), the calico bass, **Pomoxis sparoides, (Lacepede)**, and, to a lesser extent, the blue-gill sunfish, **Helioperca incisor** (C. and V.).

Larvae are always many times more abundant than pupae in bottom samples as well as in net hauls out in the lake; hence the large proportion of pupae in the stomachs of these fishes indicate that the pupae were available for attack near shore. Thirdly, a continuous mortality of larvae occurs owing to fish predation, death from disease, and other causes. Dead larvae on the surface of the water are a frequent finding.

On the basis of the emergence represented by the fiv cages

in line A in 1939 the overwintering generation accounted for at least 163 gnats per square foot and the summer generation totaled 325, or twice the original overwintering population. This includes only the emerged individuals and does not take into account the larvae that did not produce adults, but overwintered. In 1940 the overwintering generation accounted for an estimated 127 per square foot and the summer generation totaled 535, or an increase of 4¼ times. In spite of the insect's high biotic potential it is evident that forces are operative to keep the multiplication low.

It is calculated that the total seasonal production on the upper, or larger, arm of the lake, comprising 44 square miles, on the basis of emergence from the five cages was approximately 531 billion gnats, or 266 tons, in 1939. The daily average was approximately 3½ billion, or 3,474 pounds. These figures represent the number of gnats actually recovered and perhaps is a minimum estimate because factors such as greater emergence in other areas and spiders in cages reduced the average. In 1940 the total production was computed to be 712 billion gnats, or 356 tons. The daily average was 4,655 pounds with a maximum of approximately 14 tons. The greater production in 1940 was due to heavy and frequent oviposition in May and June, which was brought about by above-average temperatures and much calm weather. In May and June, 1939 conditions were not favorable for oviposition.

One night's emergence of gnats (3½ billion) spread over the country-side would provide a high degree of infestation. If these should be spread evenly for a mile back of shore, there would be approximately 5 gnats per square foot, or, if figured on a cubic-foot basis, one-half gnat per cubic foot if they are extended equally up to 10 feet into the air. Sweepings with a net on a car over extended areas have shown that the cubic-foot population seldom exceeds 10; usually the average is from less than 1 to 1 or 2 per cubic foot. Concentrations along shore or around lights, of course, have greater densities.

Frequent examinations of the cages in the daytime and in the evening up to 11 P. M. did not disclose any emerged gnats. Examinations from 6 to 8 A. M. always showed insects in the cages. It was concluded that emergence occurs between 11 P. M. and 6 A. M.

Seining with a plankton net and the taking of samples at different depths with a Kemmerer water bottle during the evening hours revealed that larvae ascended from the bottom earlier than the pupae and that pupae were seldom recovered near the surface before midnight.

In July a series of cages were operated so that emerging insects were collected at various hours during the night. During an 11-day period the greatest emergence took place from 12 to 6 A. M.

The sex ratio of 7,044 individuals taken from the cages in 1938 showed 60.2 per cent males and 39.8 per cent females. In 1939, 20,886 specimens showed an equal sex ratio. No sex-ratio difference was observed from different locations, but the daily ratio varied considerably.

EMERGENCE AT OTHER POINTS ON THE LAKE

Cages were operated intermittently at various places on the lake. Three series of three cages each were operated approximately equidistant off the east shore at Nice, Lucerne, and Russ Cove. All cages showed a progressively declining emergence away from shore, although this varied during short periods.

The location of the first five cages in line A and an extension of the line farther out into the lake and toward the west shore is shown in fig. 2. The emergence shown per square foot is during

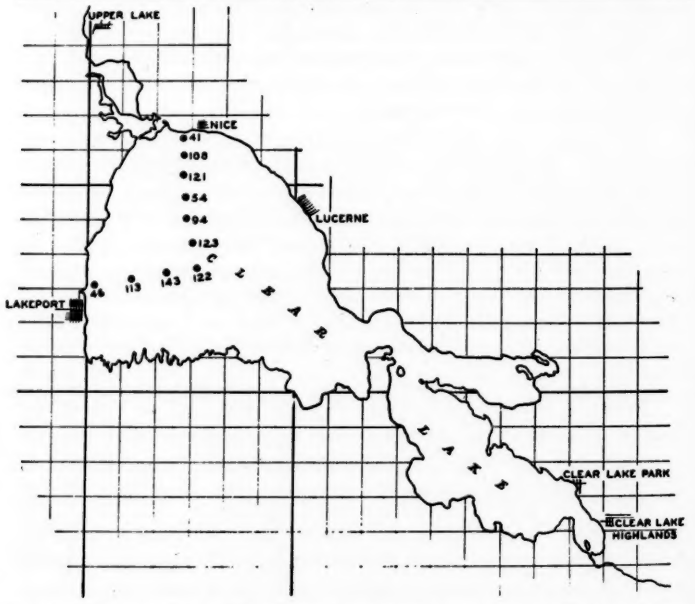

Fig. 2—Emergence of **Chaoborus astictopus** per square foot in cages during the period June 14 to July 11, 1940.

a 28-day period in June and July, 1940. This and other temporary cage settings indicate that emergence occurs over the entire lake area.

SUMMARY

Floating cages were used to study the emergence of **Chaoborus astictopus** from Clear Lake, Calif. Records from a line of five recovery cages on the lake operated in 1939 and 1940 showed that emergence occurred every day throughout the season during the 2 years of study, except 8 days in 1939 and 6 days in 1940, when storms prevented examination of the cages. The daily emergence was sporadic and irregular and ranged from less than 1 to 75 gnats per square foot. The average seasonal recovery was 487 per foot in 1939 and 654 per foot in 1940. The emergence was greatest within three-fourths of a mile from shore, the two cages in this area taking 57.2 per cent of the total recovery in 1939 and 55.7 per cent in 1940. Samples of bottom mud taken throughout the summer at the cages showed a scanty larval and pupal population near shore and a high population farther out.

The peak activity was in the last half of July in 1939 and in the first part of August, 1940. A fairly gradual increase in emergence occurred before the peaks and a decline thereafter. The overwintering generation continued to emerge over a 67-day period in 1939.

The pest emerged in the spring in good numbers at a water temperature of 62° to 70° F., but during the fall pupation and emergence were greatly reduced at 70° and nearly ceased at 65°. On the basis of the emergence represented by the five cages in 1939 the overwintering generation accounted for at least 163 gnats per square foot and the summer generations totaled 325, or twice the original overwintering population. In 1940 the overwintering generation accounted for an estimated 127 per square foot and the summer generations totaled 535, or an increase of 4¼ times.

An estimate of the total seasonal emergence from the upper, or large, arm of the lake, comprising approximately 44 square miles, on the basis of the recovery cages was approximately 531 billion, or 266 tons, of **Chaoborus astictopus** in 1939. In 1940 the total production was approximately 712 billion gnats, or 356 tons.

The sex-ratio of 27,930 emerged individuals taken from recovery cages on the lake showed 60.2 per cent males and 39.8 per cent females. The emergence occurred during the night between the hours of 11 P. M. and 6 A. M.

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ACIDIFIED NICOTINE SPRAYS FOR HORN FLIES ON CATTLE

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Nicotine has been in common usage as an insecticide against certain phytophagous insects for many years. Ordinarily it is used as a nicotine sulfate solution with or without soap, or as nicotine or tobacco dust. Lime is often added to the solutions and dusts to liberate the toxic nicotine more quickly.

The use of nicotine as an insecticide against the external parasites of domestic animals is infrequent mainly because of the danger of nicotine poisoning of the animals.

Nicotine is extremely toxic to the horn fly (**Haematobia irritans** (L.)). The writer has killed quite easily horn flies and stableflies (**Stomoxys calcitrans** L.) with tobacco smoke, fumes from nicotine solutions, and nicotine sprays. This paper, however, is primarily concerned with the toxicity of nicotine sprays as used against horn flies.

Nicotine, as ordinarily used, is rapidly dissipated. The toxicity of a 0.5 per cent aqueous nicotine solution to horn flies on cattle is lost in about 15 minutes at 90 degrees F. The addition of certain acids to nicotine solutions not only prolongs the toxicity of the nicotine but evidently lessens the danger of nicotine absorption by the animal.

Initial tests indicated that when glacial acetic acid was added to solutions of nicotine sulfate, the toxicity of the spray on the cattle was prolonged. The spray had no harmful effect upon the animals, and the solution was stabilized. The glacial acetic acid, however, imparted a sharp odor that was slightly repellent to horn flies and would certainly be objectionable around dairy barns. Subsequent tests with weak aqueous solutions of pure nicotine and certain acids disclosed some interesting results.

Tests with nicotine sprays against horn flies on cattle were started in 1939 and continued, intermittently, in 1940 and 1941.

PROCEDURE

The method used in testing the toxicity of nicotine sprays against horn flies was different from, and is believed to be superior to, those generally used. The testing of fly sprays and fly repellents on cattle is usually carried on in the field, the killing power or repellency of the spray material being ascertained by regular observations of infestations. Cattle thus exposed in nature are subject to infestations of transient flies and to loss of flies by migration. Furthermore, it is extremely difficult, if not impossible, to determine the actual fly mortality. In the present tests with nicotine sprays the test animal was confined in a screened building and infested with a known number of flies. The actual number of flies alive at the time of each observation could therefore be accurately determined. In the initial tests the animal was sprayed in the screened building. Later, to obviate the possible effect of fumigation and spray residue on the sides of the building, the animal was sprayed outdoors and then confined in the screened building, after which a known number of flies were released on the animal. The mortality of the flies was recorded and the effect of the spray material on the animal noted.

In considering these tests it is well to bear in mind two facts: (1). Horn flies remain on the host continuously, and (2) they are quickly knocked down by nicotine but some recover from an initial dose. In this latter case the flies return to the animal and, if the toxicity of the spray persists, the flies will receive a second and possibly a third dose.

Nicotine Sprays

Pure nicotine was used in compounding an aqueous solution containing approximately 0.42 per cent of nicotine. A yearling heifer was confined in a screened building, infested with 100 horn flies, and sprayed with a hand sprayer using 40 ml. of the solution. All the flies were immediately knocked down, but a few subsequently recovered. Ten horn flies were alive 2 hours after the spraying. The addition of formalin (2 per cent) to prevent the growth of bacteria and molds in the solution did not materially alter the toxicity of the spray.

Nicotine Sulfate Sprays

A yearling steer was confined in a screened building, infested with 100 horn flies, and sprayed with approximately 50 ml. of an aqueous solution of commercial nicotine sulfate containing 0.4 per cent of nicotine. All the flies dropped from the animal within a few minutes after the spraying, but some recovered. Twenty-eight flies were still alive after 5 hours.

Nicotine Sulfate and Glacial Acetic Acid

Nine tests were made with aqueous solutions of nicotine sulfate

containing 5 per cent of glacial acetic acid and from 0.12 to 1.00 per cent of nicotine. In one test 30 ml. of a 0.5 per cent solution gave a 100 per cent kill of 100 horn flies released before spraying and only a 30 per cent kill of 100 horn flies released 1 hour after spraying. In another test 30 ml. of a 1.0 per cent solution gave a 100 per cent kill of 100 horn flies released immediately after spraying and a 58 per cent kill of flies released 1 hour later. Again, a 2-year-old heifer was sprayed with 60 ml. of a 1.0 per cent solution and infested with 100 horn flies immediately after spraying, another 100 flies 1 hour after spraying, and a third 100 flies 2 hours after spraying. Only 16 flies were alive 6 hours after spraying. Glacial acetic acid alone had no toxic effect upon horn flies as demonstrated in one test in which a 2-year-old heifer was sprayed with 30 ml. of a 5 per cent solution. The animal was confined in a screened building and infested with 100 horn flies. Six hours after spraying, all the flies were alive.

Nicotine Malate

The aqueous solutions of nicotine malate were compounded from pure nicotine and malic acid, with a moderate excess of malic acid. Only four tests were made with nicotine malate containing 0.5 per cent of nicotine and approximately 1.0 per cent of malic acid killed 98 per cent of the horn flies that were on the animal at the time of spraying.

Nicotine Lactate

The aqueous solutions of nicotine lactate were compounded from pure nicotine and lactic acid, with an excess of the acid. The stock solution of nicotine lactate containing 5 per cent of nicotine and 10 per cent of lactic acid. Ten tests with nicotine lactate solutions gave consistently excellent results. Thirty-five ml. of a nicotine lactate solution containing 0.42 per cent of nicotine killed all 100 flies on the animal at the time of spraying. One animal was sprayed with 340 ml. of nicotine lactate containing 0.5 per cent of nicotine and infested with 100 horn flies immediately after spraying and each hour thereafter for 5 hours. A 100 per cent mortality was recorded for each of the first five infestations and a 50 per cent mortality of the 100 flies released 6 hours after spraying. In another test 150 ml. of nicotine lactate containing 1.0 per cent of nicotine was sprayed on a yearling heifer. Approximately 100 horn flies were released each hour for 7 hours. All the flies were killed except 6 of the 100 released 7 hours after spraying. Nicotine lactate is nonrepellent, but the flies soon succumb after coming in contact with a sprayed animal.

Nicotine lactate sprays had no harmful effect upon the cattle. However, one steer exhibited a little uneasiness 2 hours after 500

ml. of nicotine lactate containing 0.5 per cent of nicotine had been briskly applied with a brush.

Aqueous solutions of nicotine and of nicotine sulfate were unstable and in a few days become cloudy and "stringy." This condition was evidently due to the growth of bacteria and molds since one or both these growths were found in the solutions as shown in the following table:

Hydrogen-Ion Concentration and Bacteriological Tests of Nicotine Solutions[1]

Material	Nicotine, per cent	pH[2]	Bacteria	Molds
Nicotine	5.0	8.4+ +	— ?	+ +
Nicotine plus 2% formalin	5.0	8.4+ +	—	—
Nicotine sulfate plus 5% glacial acetic acid	0.6	4.8— —	—	—
Nicotine lactate	0.5	4.8—	+	+ +
Nicotine lactate plus 2% formalin	5.0	4.8—	—	—
Nicotine lactate plus 0.5% sodium benzoate	0.5	4.8—	+ + +	—
Nicotine malate	5.0	4.8—	+ +	+ ?
Nicotine malate plus 2% formalin	5.0	4.8—	—	—
Nicotine sulfate	4.0		+ +	
Nicotine sulfate plus 5% glacial acetic acid	0.3		—	

[1]Colorimetric pH tests (limited between 4.8 and 8.4) and agar slant and agar plate tests for bacteria and molds made by Dr. E. W. Laake.

[2]+ + well above 8.4, — slightly below 4.8, — — well below 4.8.

The addition of glacial acetic acid or formalin to the solutions inhibited the development of bacteria and molds and the solutions remained clear for over 1 year.

SUMMARY

Experiments were conducted to determine the toxicity of nicotine sprays against horn flies on cattle. When certain acids were incorporated in the nicotine sprays the toxicity was prolonged and the spray was considerably more effective against horn flies than when no acids were added. Nicotine lactate, an aqueous solution of nicotine containing 0.5 per cent of nicotine and 1.0 per cent of lactic acid, and the combination of nicotine sulfate and acetic acid, were effective, but the latter was objectionable because of its disagreeable odor.

ADDITIONS TO THE "ROBBER FLIES OF COLORADO."

MAURICE T. JAMES, Colorado State College

In the present supplement to my "Robber Flies of Colorado,*" only data which will materially extend either the geographical or altitudinal range or our knowledge of the taxonomy of the species are included. Three species (numbers 148 to 150) are added to the Colorado list, one of them being new to science.

3. **Leptogaster coloradensis** James. Falfa, 7000 ft., May 31, 1940 (Rotger).

8. **Comantella fallei** (Back). Las Animas, Nov. 15, 1940 (T. R. Robb).

17. **Lestomyia strigipes** Curran. Arboles, May 12, 1939 (Rotger); Allison, June 10, 1940 (Rotger).

20. **Buckellia brevicornis** (Williston). Evergreen, Aug. 6 & 8. 1941 (James). Fairly common on fallen logs of **Pinus ponderosa.**

46. **Lasiopogon oklahomensis** Cole & Wilcox. Snow Ball R., Mineral Co., 9000 ft., June 20, 1940 (B. Rotger).

48. **Lasiopogon aldrichii** Melander. Science Lodge, near Ward, June 20 & Aug. 15, 1940 (U. N. Lanham).

50. **Coleomyia alticola** James. Phillipsburg, Aug. 5, 1941 (James); Evergreen, Aug. 8, 1941 (James); Gould, near Cameron Pass, Aug. 19-21, 1941 (James). The number of hypopleural bristles seems to vary from one to three or four.

54. **Cyrtopogon pulcher** Lw. Evergreen, July 13, 1941 (James); Phillipsburg, Aug. 5, 1941 (James). The third antennal segment varies from wholly red to wholly black.

56. **Cyrtopogon dasyllis** Will. Science Lodge, near Ward, Aug. 15, 1941 (Lanham).

62. **Cyrtopogon montanus wilcoxi,** n. ssp.

Cyrtopogon montanus James, 1941, Jour. Kans. Ent. Soc., 14:41.

More Eastern in distribution than typical **montanus,** and the form which I have taken for **leucozona** Lw. The abdominal pollinose bands on segments two to four of both sexes and on five of the female are entire, the abdomen is less glossy, the abdominal pile in the female and the lateral pile on approximately the white-pollinose area of the male is white, the entire insect is accordingly paler in color than the typical form. The front tarsi are characteristically reddish, and the mystax as a rule more extensively black.

Holotype, male, **allotype,** female, and **paratopotypes,** 5 males, 2 females, A.S.U.C. Lodge, Boulder, Colo., June 15, 1933. **Paratypes:**

*Jour. Kans. Ent. Soc., 14: 27-53, 1941.

1 female, Raymonds, Colo., July 10, 1937 (James); 1 male, 1 female, Boulder, Colo., June 26, 1933 (M. & H. James); 2 males, Boulder, Colo., June 27, 1932 (James); 1 male, 1 female near Ward, Colo., June 2-9, 1933 (H. G. & H. E. Rodeck); 1 male, 2 females, Boulder, Colo., June 22, 1935 (E. I. & R. H. Beamer); 1 male, Hinsdale Co., Colo., June 28, 1937 (R. H. Beamer); 1 female, Edwards, Colo., June 25, 1932 (L. G. Davis); 1 female, Larimer Co. foothills, Colo., June 26, 1915 (M. A. Palmer); 2 females, Longs Peak, Colo., July 10, 1917 (M. Dings); 1 male, Gold Hill, Colo., June 24, 1932 (James); 1 female, Lonetree, Colo., May 11, 1934 (B. Rotger); 7 females, 2 males, Evergreen, Colo., June 28-30, July 1, 1941 (James); 1 male, 1 female, Boulder, Colo., May 14, 1939 (R. Bauer); 1 male, 15 miles north of Meeker, Colo., June 15, 1939 (U. Lanham); 1 male, Grand Mesa, Colo., July 7, 1938 (Lanham); 1 male, Glacier Lake, Boulder Co., Colo., June 28, 1937 (Helen Rodeck); 1 female, Muskee Lake, nr. Nederland, Colo., June 23, 1936 (Helen Rodeck); 1 female, 8 miles east of Ward, Colo., June 24, 1939 (Lanham); 1 female, Peaceful Valley and Allens Park, Colo., July 6 (Cockerell); 1 female, 7 miles south of Glade Park, Colo., June 21, 1938 (Lanham); 1 female, Moraine Park, Rocky Mountain National Park, June 29, 1933 (Helen Rodeck).

Named in honor of Dr. Joseph Wilcox, to whom I am indebted for suggestions and for the loan of specimens.

Specimens from western Montana, Idaho, and eastern Washington and Oregon may be typical **leucozona**. These have darker legs, the front tarsi being black. As in the Colorado series in both sexes, the abdominal pollinose bands and the pile of the abdomen are as described for **wilcoxi**. A few Colorado specimens, not designated as types, vary in one respect or another from the above description, but in general they conform.

72. **Holopogon guttula** Wd. Evergreen, July 18, 1941 (James).

79. **Asilus nitidifacies** Hine. Science Lodge, near Ward. Aug. 2, 1940 (Lanham).

83. **Asilus vescus** Hine. Evergreen, Aug. 6 & 8, 1941 (James), on fallen trunks of **Pinus ponderosa.**

86. **Asilus formosus** Hine. Ft. Collins, July 13, 1939 (James), entrance of prairie dog hole; Juanita, 6400 ft., July 3, 1938 (Rotger); Arboles, 6000 ft., July 4, 1938 (Rotger).

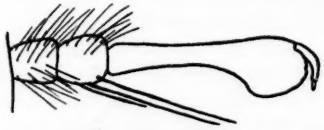
146. **Laphria aimatis** McAtee. Estes Park, June 24, 1939, and July 25, 1939 (Wayne Howe).

147. **Laphria felis varipes** McAtee. Snowball Ranch, Mineral Co., 9000 ft., June 20, 1940 (Rotger).

148. **Laphystia varipes** Curran. Ordway, Colo., July 4, 1941

(Fred Kropf).

149. **Nannocyrtopogon aristatus**, n. sp. **Male.** Head black, with dense white pollen which covers practically all the head except a large shining area on the upper half of the face; mystax, pile and bristles of vertex, front, face, antennae, and palpi, and supra-occipital bristles black; beard and hairs of lower occiput white and silky. Ratio of three antennal segments and style 6:6:23:6; third segment much enlarged at apex; style inserted on dorsal surface near apex, and resembling a short, thick arista. Thorax wholly black; pollen of middle of dorsum, except for two rows along dorsocentrals, brownish, that of thorax and scutellum otherwise white; bristles and hairs of



Nannocyrtopogon aristatus

dorsum marginal scutellars (two to four in number) and upper hypopleurals black; lower hypopleurals and pile of pleura white. Legs black; bristles and coarser hair white, fine hair mostly white, yellowish on inner surface of hind tibiae and tarsi. Wings hyaline. Halteres brown, knobs somewhat darker. Abdomen shining black, with bluish reflections; moderately long white pile laterally on first and second segments; pile otherwise short, black, most conspicuous on genitalia; pile of venter, except genital segments, scant, fine, white. Dorsum with narrow white-pollinose bands basally on segments two to five, inconspicuous on five, most prominent on three and four; sides of one and lateral posterior spots on two to six white-pollinose; venter white-pollinose except middle of segments. Length, 6-7 mm.

Female. Face entirely pollinose. Pollinose band on segment five more conspicuous. Genital spines yellow. Otherwise as in male.

Holotype, male **allotype**, female, and **paratypes**, 3 males, 4 females, Arboles, Colo., 6700 ft., May 17, 1939 (B. Rotger, C. R.), Colorado State College and Rotger collections.

The form of the antenna will distinguish this species from any other known member of the genus. The genus traces to **Cyrtopogon** in my key, but may be distinguished from that genus by the fact that the scutellum is bare on the disc and has strong marginal bristles.

150. **Erax pilosus** Hine. Towac, Montezuma Co., May 1939 (Rotger).

STUDIES IN NEW WORLD PHILIA (BIBIONIDAE)

PART I

D. ELMO HARDY, Lawrence, Kansas

The material discussed in this paper has been received from the U. S. National Museum, The American Museum, Cambridge Museum of Natural History, Dr. H. de Sousa Lopes, Rio de Janeiro, and Mr. P. C. Ting, San Francisco, California.

Philia anomala n. sp.
(figs 1a-b)

This species is somewhat related to **P. dorsalis** (Phil.) by having three sets of teeth on the front tibiae and the front coxae and femora rufous. It is distinguished by the chiefly black thorax and slender hind tibia of male and the different arrangement and number of teeth on the front tibiae in both sexes. **P. dorsalis** has five strong dorsal spines on front tibiae, two near the base and three located just beyond the middle.

Male.—Medium sized, chiefly blackish species, rather thickly covered with brown to black pile. **Head:** Compound eyes divided, upper portion brown pilose. Ocellar tubercle covered with short yellowish pile above. Rostrum produced about as long as the lower portion of the compound eyes; under portion of head with abundant long black hairs. Antennae broken in type, scape and pedicel black with a faint yellowish tinge. **Thorax:** Black, with a tinge of yellowish red in the ground color. Dorsocentral hairs strong. Halteres black. Thoracic combs rather weak, anterior comb divided medianly and composed of twelve short teeth. **Legs:** Front coxae, trochanters and femora rufous, middle femora and bases of posterior pair dark rufous tinged, legs otherwise black. Front tibiae with three sets of teeth, three to four teeth in top set, four teeth in median set and eight in the apical set besides the short apical spur. The left anterior tibia of this specimen has four teeth in top set while the right tibia has just three (figs. 1a-1b). Segments of hind legs slender, tibiae scarcely enlarged at apices, sides almost straight. **Wings:** Brownish fumose, costal margin and stigmata blackish. Abdomen black, with a faint brown tinge to the terga. **Genitalia:** Coxopodite cleft about one-third its length. Harpagones well developed, greatly thickened at bases and narrowing apically. Hind margin of ninth tergum straight or nearly so. Cerci bright yellow, conspicuous.

Length: body and wings, 5.5 mm.

Female.—Thorax entirely rufous except for brownish red pleurae. Thoracic combs more pronounced, anterior comb more distinctly divided, teeth longer. Rostrum produced longer than the eyes. An-

tennae twelve segmented. counting nipple-like tip. Middle femora and bases of posterior pair more rufous. Front tibiae with three teeth in the top set and five in the median set. Entire genitalia yellowish red, cerci bright colored and conspicuous.

Length: body and wings, 5.7 mm.

This species represents another example of sexual dimorphism in the number and arrangement of the teeth on front tibiae.

Holotype male, San Rafael, V. C. Mexico, 3-3 (Townsend). Allotype female, same data. Both returned to U. S. National Museum.

Philia globosa n. sp.

(Figs. 2a-d)

This species is related to **P. rhynchops** (Coq.) but is readily distinguished by its smaller size, the swollen subsegments of the posterior tarsi, yellow femora, and the arrangement of the spines of front tibiae.

Male.—Small, chiefly black or brownish species. **Head:** Compound eyes divided transversely at about the lower one-third. Ocellar tubercle pronounced, densely covered with fine, brownish pile on upper portion. Antennae black, composed of eight to nine closely compacted segments. Rostrum brownish, produced longer than the antennae and almost as long as the head. **Thorax:** Dorsum polished black, chiefly bare except for long, brown dorsocentral and marginal hairs, hind portion of mesonotum sometimes faintly browned. Pleurae brownish with a tinge of yellow. Stems of halteres pale, knobs black. Thoracic combs not divided, front comb composed of twelve rather bluntly pointed teeth. **Legs:** Coxae brownish, trochanters, femora and most of tibiae yellow, posterior tibiae brownish black at apices; teeth of front tibiae reddish. Tarsi brown to black. Front tibiae each with three series of teeth on dorsal surface (fig. 2c); the top set possesses two teeth and is at basal one-third of tibia; the second set has four teeth and is just below the middle; the apical set has seven teeth besides the short black tibial spur. Pile of legs yellow to yellow-brown. Posterior femora slender, posterior tibiae clavate, thicker at apices than greatest width of femora. Tarsal subsegments strongly swollen (fig. 2d), metatarsi thicker than apices of tibiae, especially from dorsal view. Empodia and pulvilli yellow, conspicuously fringed on their margins. **Wings:** Very lightly yellow-brown fumose; stigma brown, darker than the membrane; veins yellow-brown. Abdomen shining black clothed with sparse elongate black hairs. **Genitalia:** Coxopodite with a very shallow cleft on posterior margin, extending less than a fourth the length of the segment. The median portion of the cleft possesses a well developed mound-like protrubrance which extends as long as the posterior lateral lobes. Harpagones simple, rather bluntly tipped (fig. 2a).

Ninth tergum about two times as wide as long, posterior margin straight (fig. 2b) without any noticeable concavity. Cerci large, rounded and thickly haired.

Length: Body, 3.3-3.5 mm.; wings, 3.2-3.4 mm.

Female.—The female differs in being almost entirely reddish-yellow with only the head and last few tarsal subsegments black; the abdominal sclerites and knobs of halteres are brownish. The scape and pedicel of antennae are yellowish; the rostrum is produced longer than head; the posterior tibiae only slightly clavate and the tarsal subsegments slender.

Holotype male, allotype female and one paratype male: Cantareira, Sao Paulo, Brazil, 8-9-34 (S. Lopes et L Trav. F.)

All in Snow Entomological Collection.

Philia minima n. sp.
(figs. 3a-b)

Related to **P. plaumanni** (Edwards) but readily distinguished by its small size, different number and arrangement of teeth on front tibiae, entirely rufous thorax and legs and the hyaline wings and colorless stigmata.

Male.—Very small species. **Head:** Compound eyes divided by a transverse depression near the lower one-third, very sparsely yellowish pilose. Ocellar tubercle prominent, with fine yellow pile on upper portion. Antennae eight segmented, basal segments yellow. Rostrum short, scarcely produced over half the length of antennae. **Thorax:** Entirely yellow except for slight discolorations of brownish-yellow on the pleurae. Thoracic combs slightly divided medianly, the front comb composed of ten, rather slender sharply pointed teeth. Dorsocentral hairs strong. Stems of halteres pale, knobs brown. **Legs:** Chiefly yellow, with yellow-brown pile; last three subsegments of tarsi blackish, tibiae teeth and tarsal spurs red. Front tibiae with three sets of teeth on dorsal surface. The top set has two teeth and is situated at basal one-third of tibiae, the middle set has four teeth and is located near the apical two-thirds of tibiae, the apical set has eight teeth besides the short tibial spur. These teeth are arranged as in **Philia globosa** n. sp. (fig. 2c), they are more slender and sharply pointed, however, than in that species. All leg joints slender, posterior tibiae or tarsi not at all swollen. **Wings:** Hyaline, veins only faintly yellowish, stigmata concolorous with the membrane. Abdomen brownish black, sparsely brown haired. **Genitalia:** Cleft of coxopodite extending about one-third the length of segment. The mound-like development in the median portion of the cleft not extending as far as posterior lateral margins of sternum. Harpagones simple, curved inward (fig. 3a). Ninth tergum nearly three times as wide as long, posterior margin very gently concave

(fig. 3b).

Length: body, 2.2-2.6 mm.; wings, 2.4-2.7 mm.

Female unknown.

This species and **P. microcerus** (Edwards) are the smallest **Philia** known to the writer.

Holotype male and nine paratype males; Higuito, San Mateo, Costa Rica (Pablo Schild).

Holotype and five paratypes returned to U. S. National Museum, others retained in Snow Entomological Collection.

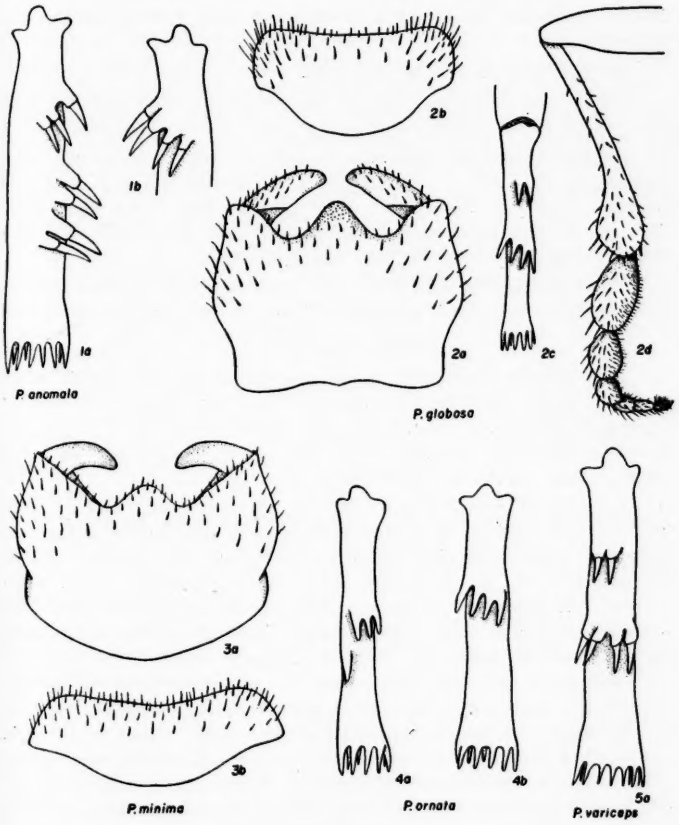
Philia ornata n. sp.

This species is more nearly related to **P. luteus** (Edwards). The males are distinguished by the different arrangement of the teeth on anterior tibiae: three teeth in top set and just a single tooth between this and the apical set, instead of having two teeth in each of the dorsal sets; chiefly black legs and concolorous stigmata and by the radius, radio-medial crossvein and stem of medius bare instead of with stout hairs. The females are separated by the black pleurae, tibiae and posterior femora and brown posterior veins.

Male.—Medium sized, chiefly black species. Head: Compound eyes sparsely covered with short brown pile. Ocellar triangle shining black, entirely bare on dorsal portion. Compound eyes divided on about lower third. Rostrum slightly produced but short, scarcely over half the antennal length. Antennae broken in type male, probably nine segmented, scape and pedicel blackish-brown. Under portion of head and rostrum with scattered long white hairs. **Thorax**: Entirely polished black, except for faint brownish tinge on pleurae; with sparse yellowish hairs on dorsum. Thoracic combs not divided medianly, the anterior comb composed of twelve rather small teeth. Knobs of halteres black, stems slightly yellowed. **Legs**: Coxae and middle and anterior pairs of femora brownish, legs otherwise black. Pile of coxae and femora yellowish, of tibiae and tarsi brown. Anterior tibiae each with a set of three teeth in a transverse row at about the middle and a single tooth at about apical two-thirds of tibiae (fig. 4a). Apical set with seven teeth besides the spur, tibial spur equal in size to the teeth. **Wings**: Hyaline, stigmata concolorous with the membrane. Anterior veins yellow, posterior very pale. Abdomen polished black except for brownish tinge on first four terga. Sparsely yellow pilose.

Length: body, 6.0 mm.; wings, 3.33 mm.

Female.—The dorsum of thorax, front and middle coxae, trochanters and femora yellow. Pleurae black, with a brownish-yellow tinge. Antennae eleven segmented, including the button-like tip, scape and pedicel yellow. Rostrum marked with yellow above and below, slightly longer than in male but much shorter than the eye



EXPLANATION OF PLATE

Fig. 1. **Philia anomala** n. sp., a. Right anterior tibia, male. b. Left anterior tibia, upper portion, male.

Fig. 2. **P. globosa** n. sp., a. Male genitalia, ventral. b. ninth tergum of male, dorsal. c. anterior tibia of male, dorsal. d. posterior tibia and tarsus of male, lateral.

Fig. 3. **P. minima** n. sp., a. male genitalia, ventral. b. ninth tergum of male, dorsal.

Fig. 4. **P. ornata** n. sp., a. Right anterior tibia of male. b. left anterior tibia of female.

Fig. 5. **P. variceps** n. sp., a. Right anterior tibia of male.

length. Posterior tibiae with just one set of four spines above the apical set, these are arranged in slightly oblique row (fig. 4b). Wings faintly yellowish, stigmata and anterior veins brown, posteriors yellow-brown.

Length: body and wings, 6.2 mm.

This species represents one of the few known examples of sexual dimorphism in the arrangement of the teeth on the front tibiae.

Holotype male and allotype female on same pin, Gaut. City, Guatemala, El. 5000 ft., March, 1932 (C. N. Ainslie). Six paratype females: four from San Pedro de Montes de Oca, Costa Rica, 1-22-1936 (C. H. Ballou); one, San Isidro, C. R. (G. F. Tristan) and one Tegucigalpa, Honduras, II-19-18 (F. J. Dyer).

Holotype, allotype and three paratypes returned to United States National Museum, three retained in Snow Entomological Collection.

Philia tingi n. sp.*

This species is related to P. **spinipes** (Say) by having three series of teeth-like spines on each of the front tibiae, it is readily distinguished by the short costa, the black coloration, the blunt, rounding teeth of thoracic combs, its much smaller size and the shorter head length of the females.

Female.—Head: Entirely shining black, rather thickly black haired. The rostrum is produced longer than the antennae and the extended mouthparts reach almost three times the antennal length. Antennae short, the segments compacted, apparently eleven segmented, the segments of the flagellum are so compressed that it is difficult to discern their articulations. The rostrum is shorter than the antennae in **spinipes** and the mouthparts are not so elongated. The compound eyes are longer than the length of head behind the eyes, eyes of **spinipes** much shorter, more rounding. **Thorax:** Shining black, except the faintly reddish thoracic combs. Teeth of thoracic combs short and blunt, anterior comb composed of ten to twelve teeth, comb scarcely divided in the middle. Dorsocentral and marginal hairs long and thin, mesopleurae and sternopleurae with scattered long marginal pile; all thoracic pile yellowish. **Legs:** Largely black, only the front tibiae rufous; front femora and coxae faintly reddish tinged in the median portions; all tibiae and metatarsi with a very faint rufous cast in the black ground color. Front tibiae with three series of spines, the top set is situated on the upper third of the segment and contains just two teeth; the middle set is at about the median portion and has three teeth; the third or apical set is made up of eight spines counting the apical spur. All tibial spines are rather broad and blunt, the apical spur is shining black and much

*This species is figured in the forthcoming revision of the Nearctic Bibionidae.

larger than the spines at the ends of the tibiae. **Philia spinipes** has three teeth in the top set and four in the median, the spines are more acute and the apical set contains eleven or twelve teeth. **Wings:** Entirely hyaline, anterior veins and stigma brown, posteriors concolorous with the membrane. The costa extends but a short distance beyond the tip of vein R_5 (posterior branch of radius), about one-fifth the distance between tips of R_5 and M_1; the costa of **spinipes** extends half the distance between these veins. The abdomen is blackish-brown, the sclerites and conjunctiva of the venter are faintly tinged with yellowish. Cerci black, covered with thick yellow pile.

Length: body and wings, 3.4-3.5 mm.

Male.—Compound eyes sparsely brown to black haired, lower one-third to one-fourth of each eye is divided off by a transverse depressed area. Rostrum longer than antennae and covered with dense black hair and mouthparts produced as in female. Body and legs entirely black.

Length: Body and wings, 3-3.1 mm.

Holotype female, Cronise Lk., San B. Co., Cal., April 28, 1937, No. 300 (P. C. Ting). Allotype male and two paratype females, same data as type. These specimens were collected on blossoms of Prosopis.

The writer takes pleasure in naming this species after Mr. P. C. Ting, State of California, Department of Agriculture, who has contributed much valuable information concerning the immature stages of the Bibionidae.

Holotype, allotype and one paratype in Snow Entomological Collection, by permission of Mr. Ting, and one paratype deposited in U. S. National Museum.

Philia variceps n. sp.

(fig. 5a)

This species is related to **P. castanipes** (Bigot) but is distinguished by its much smaller size; the vertical brown stripe occupying most of the mesopleurae and sternopleurae; the yellow scutellum and chiefly yellowish legs; the difference in number and arrangement of spines on front tibiae and shorter apical spurs.

Female.—Head: Shining black, with sparse dark hairs. Rostrum produced about three fourths the length of the compound eyes, portion of head behind the eye slightly longer than the rostrum. Antennae eleven segmented, chiefly yellowish, only the apical four to six segments brown. Labella yellow-brown, palpi brown. **Thorax:** Entirely yellowish except for brown mesopleurae and sternopleurae, black anterior comb and brownish area between the thoracic combs.

Combs not especially prominent, anterior comb divided medianly, composed of twelve to fourteen rather sharp teeth. Stems of halteres pale, knob brown. **Legs:** Coxae, trochanters, most of tibiae and metatarsi bright yellow, apices of tibiae, metatarsi and remaining tarsal subsegments black. Pile yellow-brown to black. Front tibiae with three sets of spines on dorsal surface, the top set is located at basal one-third and composed of two spines, rarely three; the median set is near the apical two-thirds of tibiae and made up of four spines (fig. 5a); apical set composed of nine spines, apical spur about equal in size to the spines. All leg joints slender. **Wings:** Brownish-yellow fumose darker on anterior margin. Stigmata and veins brown. Abdomen brownish-black, genitalia yellowish.

Length: body and wings, 4-4.66 mm.

Male unknown.

Holotye female: Tabernilla Canal Zone, Panama, May, 1907 (August Busck). Six paratypes: one, same data as type; one Trinidad Rio Panama, III-26-12 (A. Busck) and four Barro Colo. Isld., Canal Zone, XI-22 to I-9-1929 (M. Bates, Griswold and C. H. Curran).

One female specimen from Chimbotes Amaz. Peru., Mar. 20, 31 (R. C. Shannon) apparently belongs to this species.

Holotype, one paratype and the Peruvian specimen are being returned to the United States National Museum, one returned to the American Museum, two to Cabridge Museum of Comparative Zoology and two retained in Snow Entomological Collection.

AN OBSERVATION ON PROMACHUS, A LARGE ROBBERFLY

RAYMOND ROBERTS, University of Nebraska

After reading a note by G. F. Knowlton and G. S. Strain of the Utah Agricultural Experiment Station, in the Bulletin of the Brooklyn Entomological Society, Vol. 37, p. 42, just received, I am forced to write of a personal experience with a large robberfly of the genus **Promachus.** I have felt for several years that I should report this observation but there are a couple of things which make it indefinite. In the first place, while I captured the fly, I did not at the time attribute sufficient importance to the incident as to identify the species, and by the time that I considered writing it up several years had elapsed.

The fall of 1926 I was walking along a drive at the end of a cornfield where large robberflies sat on the ends of dried weed stalks waiting for grasshoppers to hop up or take flight. In some cases grasshopper nymphs were captured while in the air. I never saw a robberfly attempt to capture an insect on the ground. With almost unerring accuracy, however, one of these large flies would take off, the loud hum of its wings indicating the speed of its flight, and it would catch a grasshopper in mid-air. On one such occassion a fly caught a grasshopper so close to me, and alighted upon a twig so close, that I was tempted to reach out and catch the fly and its prey with a sweep of the hand. My cyanide bottle, of course, was in my right hip pocket, and I had to reach around and get it with my left hand and remove a screw cap. This procedure was rather clumsy and required some time.

The robberfly was hesitant, at first, to release its hold upon the grasshopper, but when it set up a warning buzz and did not gain its release, it let go of the grasshopper and inserted the beak into my index finger between the first and second joints. I am amazed at the complacency with which the authors referred to above state, "The 'bites' were temporarily painful." My finger swelled up until it was impossible to flex it but slightly when closing my hand. On the second day there were severe shooting pains running up my arm and I had a large glandular lump under my arm. The discomfort continued to some extent for a week.

It is said that only a relatively few rattlesnakes have enough venom in the poison sacs to cause a fatal bite to a full-grown person at any particular time. This robber fly had just injected sufficient poison into the body of the grasshopper to kill it, for I saved the fly and the grasshopper and I observed the hopper for almost two weeks. Although it was moving slightly when I captured the fly with it, the grasshopper never recovered. The entire procedure from the time that the grasshopper was captured was only a matter of seconds. The salivary or poison injection of the fly must be a violent poison for these flies capture many insects every day. This bite was more than a mechanical puncture as would be indicated by the report of Knowlton and Strain. It involved the injection of a paralyzing fluid.

I assume that Knowlton and Strain mean by "transporting grasshoppers," the activity of the flies in carrying large grasshoppers from the point of capture to a suitable feeding place, atop some twig, as I have indicated. The Diptera do not make provision for their larvae which would eliminate purposeful transportation or storage of grasshoppers.

A NEW GENUS IN THE HALOBATINAE (GERRIDAE-HEMIPTERA)

EUGENE E. KENAGA, Lawrence, Kansas*

In 1935, Drake and Harris described **Halobatopsis parvulus.** This species does not conform with the generic concept of **Halobatopsis** and is not congeneric with **Halobatopsis platensis** Berg. I therefore propose a new genus for **Halobatopsis parvulus** D & H and describe three new species to add to this new genus.

Ovatametra new genus

Eyes shorter than head, width about two-thirds interocular space. Antennae over half length of body. First segment usually longest or subequal to fourth; second segment shortest or subequal to third; fourth segment longer than third. Rostrum extending beyond anterior coxae but not beyound anterior third of mesosternum. Pronotum shorter and narrower than head, anterior margin straight, posterior margin straight in male, much rounded in female, lateral margins rounded. Mesonotum distinctly separated from metanotum, moderately convex, much widened posteriorly, posterior margin moderately curved anteriorly. Metanotum indistinctly divided into two parts; metanotum plus first abdominal segment appearing as a continuous plate, longer than mesonotum.

Anterior femur as long or longer than medial length of mesonotum, tibia at least three-fourths length of femur, tarsus about half lengh of tibia, second segment four times length of first. Intermediate femur much over half length of tibia; tibia not as long as body; tarsus subequal to or longer than femur, first segment longer than second. Posterior femur less than twice length of anterior femur, less than twice posterior tibia; tibia shorter than medial length of pronotum and mesonotum combined; tarsus about two-thirds length of tibia, first segment shorter than second.

Ovatametra is most closely related to Halobatopsis and Trepobates.

Ovatametra differs from Halobatopsis by:

1. Intermediate tibia not as long as body.
2. Posterior femur not twice length of anterior femur.
3. Metanotum plus first abdominal segment subequal to or longer than mesonotum.
4. Intermediate tarsus subequal to or longer than intermediate femur.
5. Posterior tibia shorter than medial length of pronotum and mesonotum.

*Contribution from the Department of Entomology, University of Kansas.

Ovatametra differs from Trepobates by:

1. Metanotum plus first abdominal segment subequal to or longer than mesonotum.
2. First antennal segment slightly longer or subequal to fourth, third antennal segment slightly longer or subequal to second.
3. Body length only twice body width.
4. Posterior margin of female pronotum convexly rounded.

Ovatametra parvula (D. & H.)

Halobatopsis parvulus, Arkiv för zoologi, Uppsala, Band 28 B, no. 2., p. 3 -1935.

"Small, ovoid; black with yellowish-brown markings. Head with a broad median stripe and a narrow one on each side near the eye black, these all connected behind. Eyes large, brownish, with darkened areas, the distance between them about one and a half times the diameter of each eye. Antennae brownish, the apical portion of basal two segments and all of apical segments darker. Segment I longest, II shortest, IV a little longer than III and slightly shorter than I. Rostrum stout, extending upon the mesosternum, the basal segment yellowish brown, the rest darker.

"Pronotum short, rounded behind, the posterior margin and an elongate spot on each side of median line yellowish-brown. Mesonotum subtruncate behind, black, a large spot and two stripes on each side yellowish-brown. Legs dark, long. Abdomen beneath yellowish-brown.

"Length, 2.28 mm.; width, 1.14 mm.

"Holotype, apterous female, Manaos, Amazon; Roman; Stockholm Museum.

"This species may be recognized at a glance from **H. platensis** (Berg) by its much smaller size, shorter legs, and the proportion of the antennal segments. In some respects the structure of the thorax is somewhat intermediate between that of **H. platensis** and various species of **Trepobates** Uhl. The form of the body, however, seems to leave little doubt as to it being a member of the genus **Halabatopsis** Bianchi."

Notes. O. parvula differs from the genera Halobatopsis and Trepobates by the characters given in the generic description. **O. parvula** differs from **O. minima** in lighter color pattern and from **O. obesa** and **O. fusca** in smaller size.

Ovatametra minima n. sp.

Apterous form

Size. Male 2.0-2.22 mm. long, 0.7-1.0 mm. wide; female 2.0-2.2 mm. long, 1.0-1.1 mm. wide.

Color. Body yellowish-tan except mesonotum with black marking. Antennae with basal half of first and second segments light yellow, the rest brown. Head with dark mark in center of head usually surrounded by alternating variable bands, light first, dark again and light on posterior margin and margin of eyes. Apical half of rostrum dark. Pronotum with margin between eyes dark, with dark spots back of eyes and medially, extending to or nearly to posterior margin. Mesothorax with three dark longitudinal bands on side extending from anterior to posterior margins, except most dorsal pair which may be interrupted. Mesonotum chestnut brown, anterior margin dark, medial dark triangular mark of variable size on posterior half, sometimes running forward to coalesce with anterior margin. Orange markings on metanotum and abdomen variable, usually on posterior margins of segments. Legs brown except inside of anterior femora light yellow. Venter light yellow, except males with dark lateral markings on abdomen. Genital segments brown.

Structural characteristics. Antennal formula 1st: 2nd: 3rd: 4th: : 39: 25: 25: 39 in male; 40: 28: 28: 40 in female. Interocular space one and one-half times eye width. Anterior femur slightly longer than mesonotum; tibia three-fourths length of femur with dark recurved spine-like hairs on under side in male; tarsus less than one-half length of tibia, first segment one-fourth length of second. Intermediate femur about seven-tenths length of tibia, tibia as long as medial length from anterior margin of pronotum to apex of abdomen; tarsus slightly longer than femur, first segment slightly longer than second. Hind femur less than twice length of tibia; tarsus two-thirds length of tibia, first segment subequal to second. Pronotum: mesonotum: metanotum plus first abdominal segment : : 22: 49: 51 in male; 20: 57: 63 in female. First ventral abdominal segment subequal to preceding two in female, shorter in male.

Holotype male, allotype, and twenty-five paratypes, Porto Velho, R. Madeira, Brazil, S. A., 9-37, A. M. Olalla. All types in Francis Huntington Snow Entomological Museum, University of Kansas, Lawrence, Kansas.

Notes. **O. minima** differs from other species of this genus by darker dorsal color on mesonotum; absence of dark markings on abdomen; and by smaller size.

Ovatametra obesa sp. n.

Apterous form

Size. Female 2.9-3.1 mm. long, 1.6 mm. wide.

Color. Body dark yellow with black markings. Antennal segments with apical ends dark, last segment all dark. Head with

variable markings, black with longitudinal yellow stripes. Apical two-thirds of rostrum dark. Pronotum with anterior margin black, pair of black spots running back of eyes nearly to posterior margin, median dark band extending nearly to posterior margin. Mesothorax with three black longitudinal bands on each side extending from anterior to posterior margin. Mesonotum with pair of large oval yellow spots on each side of median dark line, surrounded on all sides by black. Metanotum and abdominal segments dark, posterior margin yellow. Legs variable with yellow and dark indistinct markings. Venter light yellow with black on median portion of abdomen and posterior portion of mesosternum. Genital segments dark yellow.

Structural Characteristics. Antennal formula 1st: 2nd: 3rd: 4th: : 52: 36: 37: 52 in female. Interocular space one and a half times eye width. Anterior femur subequal to median length of mesonotum; tibia five-sixths length of femur; tarsus at least half length of tibia, first segment one-fourth length of second. Intermediate femur about three-fifths length of tibia; tibia slightly shorter than medial distance from anterior margin of pronotum to apex of abdomen; tarsus slightly longer than femur, first segment one and a half times length of second. Posterior femur nearly twice length of tibia; tarsus two-thirds length of tibia, first segment shorter than second. Pronotum: mesonotum: metanotum plus first abdominal segment : : 6: 18: 20. Abdomen shorter than metanotum, last dorsal segment with a distinct tuft of dark hairs on median posterior margin. Last ventral abdominal segment equal in length to preceding three segments.

Holotype female, and two paratypes, R. Amazonas (Nrte.), Region de Itacoatiara, Brazil, S. A., Jan.-Apr., 1936. A. M. Olalla. All types in Francis Huntington Snow Entomological Museum, University of Kansas, Lawrence, Kansas.

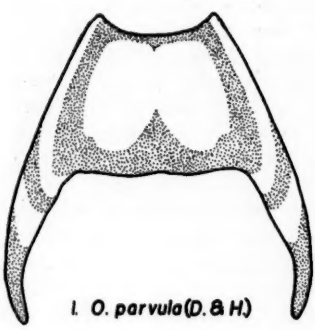
Notes. **O. obesa** differs from other species of **Ovatametra** by tuft of hair on posterior margin of last dorsal abdominal segment; by continuous dark median mark from anterior to posterior margin on mesonotum; and by larger size.

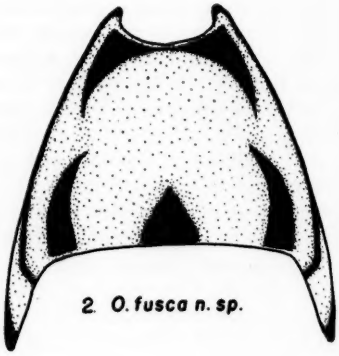
Ovatametra fusca n. sp.

Apterous form

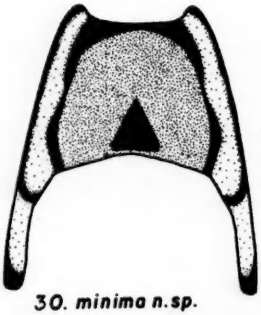
Size. Female 2.6 -2.8 mm. long, 1.4 -1.6 mm. wide.

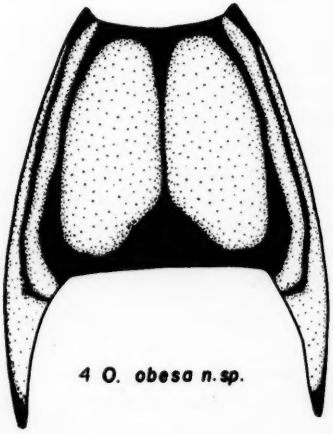
Color Body yellow with dark markings. Antennal segments mostly light with dark markings near apical ends. Head with variable markings, median and lateral dark marks sometimes connecting. Pronotum with pair of dark spots back of eyes running nearly to posterior margin, small median stripe sometimes present. Mesothorax with three dark longitudinal bands on each side from anterior to





Ovatametra n. gen.





1. **O. parvula** D. & H., dorsal view of mesothorax.
2. **O. fusca** sp. n., dorsal view of mesothorax.
3. **O. minima** sp. n., dorsal view of mesothorax.
4. **O. obesa** sp. n., dorsal view of mesothorax.

posterior margins except most dorsal pair which may be interrupted. Large dark triangular mark on posterior medial part of mesonotum. Metanotum and dorsal abdominal segments variable in color, all dark or only posteriorly dark margined segments. Venter of abdomen dark. Legs brownish.

Structural Characteristics. Antennal formula 1st: 2nd: 3rd: 4th: : 40: 28: 28: 40 in female. Second antennal segment longer than interocular space. Anterior femur longer than mesonotum; tibia three-fifths length of femur; tarsus two-thirds length of tibia, first segment one-fourth length of second. Intermediate femur about three-fifths length of tibia; tarsus longer than femur, first segment one and a half times longer than second. Posterior tibia three-fifths length of femur; tarsus two-thirds length of tibia; first segment longer than second. Pronotum: mesonotum: metanotum: : 17 : 45 : 50 in female.

Holotype female, and twenty-two paratypes. Manacapuru, S. A. Amazonas, Brazil, Solimoes River. 3 to 6 - 26. S. M. Klages, and one paratype British Guiana, Supurini Creek, Aug. 1937, S. Harris. All types in the Francis Huntington Snow Entomological Museum, University of Kansas, Lawrence, Kansas.

Notes. **O. fusca** differs from **O. minima** and **O. parvula** by larger size and different color pattern, from **O. obesa** by lack of tuft of hair on medial posterior margin of last dorsal abdominal segment, and color pattern.

Key to Ovatametra

1. Body under 2.5 mm. long ---------- 2
1. Body 2.5 mm. long or more ---------- 3
2. Mesothorax dark chestnut brown between dark longitudinal bands on dorsum; female with no dark markings on abdomen. ---------- **O. minima** sp. n.
2. Mesothorax yellow between dark longitudinal bands on dorsum; female with dark markings on venter of abdomen. ---------- **O. parvula** D. & H.
3. Last dorsal abdominal segment with tuft of dark hairs on median posterior margin; mesonotum with continuous dark median mark from anterior to posterior margins, most dorsal longitudinal dark bands connected transversely on posterior margin ---------- **O. obesa** sp. n.
3. Last dorsal abdominal segment without tuft of dark hairs on median posterior margin; mesonotum without continuous dark median mark, most dorsal longitudinal dark bands not connected transversely on posterior margin ---------- **O. fusca** sp. n.

NOTES ON DIPTERA IN SNOW ENTOMOLOGICAL COLLECTION

D. ELMO HARDY, Lawrence, Kansas*

BIBIONIDAE

Bibio stonei n. n. for **Bibio dubius** Bellardi, nec **B. dubius** Germar.

Doctor Alan Stone of the United States National Museum has pointed out to the writer that the name **dubius** is preoccupied in the genus Bibio. **Phthiria dubia** Germar was transferred to Bibio in 1856 by Giebel (Fauna Vorwelt (2) 1, 221). The combination **Bibio dubius** Germar, therefore antedates **B. dubius** Bellardi (Saggio di Ditt. Mess. I, 1859).

PSYCHODIDAE

Telmatoscopus albipunctatus (Will.), 1893, Ent. News 55, 113. The synonomy of **Psychoda snowii** Haseman with **T. albipunctatus** (Will.) has been confirmed by a study of cotypes in the Snow Collection.

Telmatoscopus niger (Banks), 1894, Can. Ent., 26, 331.

The following added synonomy is based upon a study of the cotypes in the Snow Collection.

Pericoma longiplata Haseman, 1907, Trans. Amer. Ent. Soc., 33, 308.

Pericoma scala Haseman, 1907, Trans. Amer. Ent. Soc., 33, 307-308

Psychoda cinerea Banks, 1894, Can. Ent., 26, 331.

Specimens in the Snow Collection determined (probably by Haseman) as **P. minuta** Banks proved to be **P. cinerea** Banks, although they fit the description of **P. minuta** in all details. These may prove to be synonymous.

MYDAIDAE

Opomydas limbatus (Williston) 1886, Trans. Amer. Ent. Soc., 12, 292 (Ectyphus).

The type of this species, in the Snow Collection, was labeled "**Ectyphus luteola** Williston" with the name **limbata** in parentheses in the lower left corner of the label. **E. luteola** appears to have been just a cabinet name.

DOLICHOPODIDAE

Dolichopus procerus Van Duzee and Aldrich, 1920, Proc. U. S. Nat. Mus., Bul. 116, p. 209.

*Contribution from the Department of Entomology, University of Kansas.

Examination of the type of **Dolichopus jugalis** Tucker proved it to be a synonym of **D. procerus.** The type of **D. jugalis** was labeled "**Dolichopus transjugalis** Tucker" in the Snow Collection. This again was apparently just a cabinet name.

CYRTIDAE

Pterodontia flavipes Gray, 1832, in Griffith, Animal Kingdom, Ins. XV.

Pterodontia flavoscutellata Steyskal, 1941, Bull. Brook. Ent. Soc., XXXVI, 140. New synonomy based upon a comparison of metatype specimens with typical **flavipes.** The wide range of color variations and sexual differences cover Steyskal's material.

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Vol. 15, No. 4, October, 1942